FIG.1

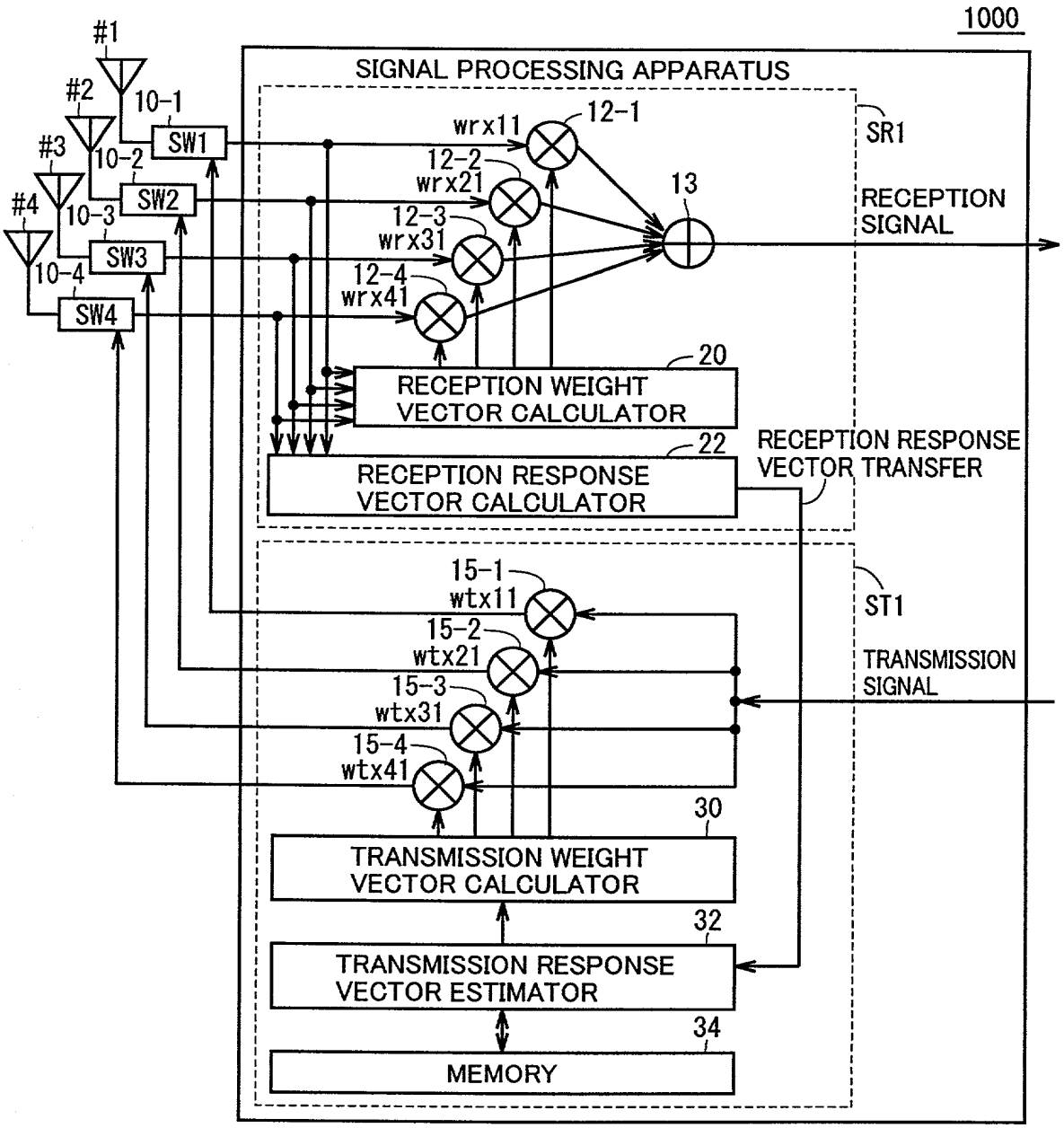

1000
SIGNAL PROCESSING APPARATUS
#1
#2
#3
#4
10-1
10-2
10-3
10-4
SW1
SW2
SW3
SW4
wrx11
wrx21
wrx31
wrx41
12-1
12-2
12-3
12-4
13
SR1
RECEPTION SIGNAL
20
RECEPTION WEIGHT VECTOR CALCULATOR
22
RECEPTION RESPONSE VECTOR CALCULATOR
RECEPTION RESPONSE VECTOR TRANSFER
ST1
TRANSMISSION SIGNAL
wtx11
wtx21
wtx31
wtx41
15-1
15-2
15-3
15-4
30
TRANSMISSION WEIGHT VECTOR CALCULATOR
32
TRANSMISSION RESPONSE VECTOR ESTIMATOR
34
MEMORY

FIG.2

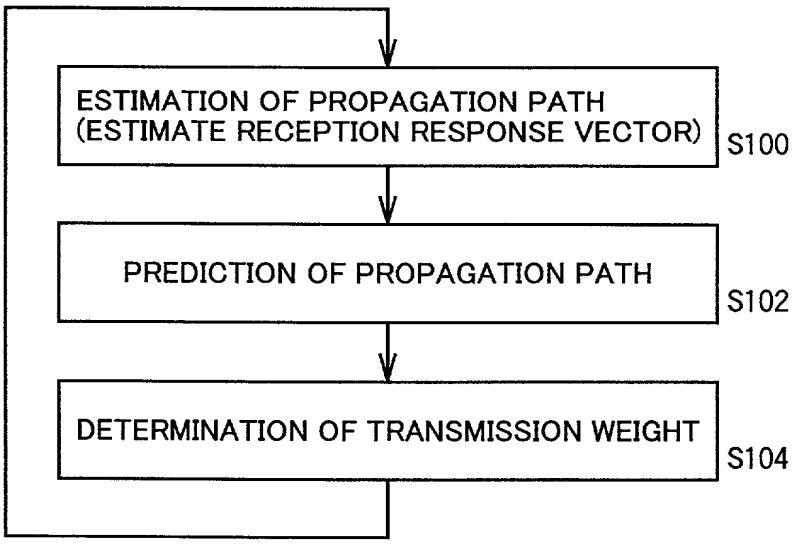

ESTIMATION OF PROPAGATION PATH
(ESTIMATE RECEPTION RESPONSE VECTOR)
S100
PREDICTION OF PROPAGATION PATH
S102
DETERMINATION OF TRANSMISSION WEIGHT
S104

FIG.3

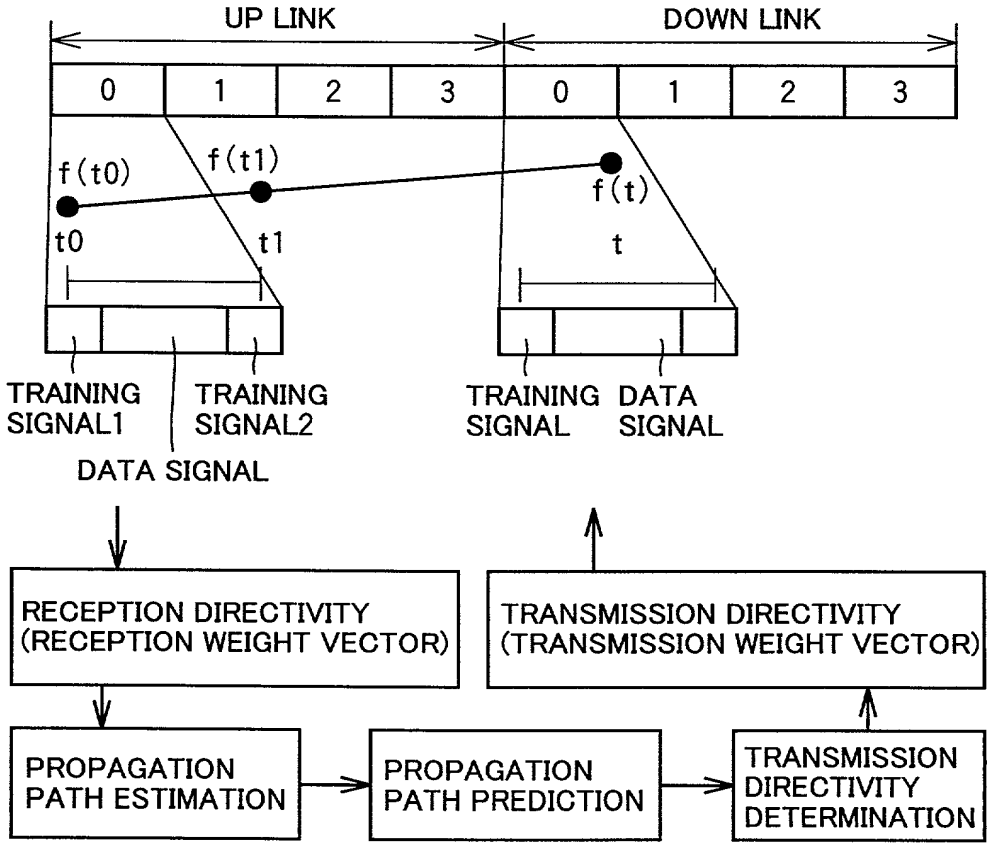

UP LINK
DOWN LINK
0
1
2
3
0
1
2
3
f(t0)
f(t1)
f(t)
t0
t1
t
TRAINING SIGNAL1
TRAINING SIGNAL2
DATA SIGNAL
TRAINING SIGNAL
DATA SIGNAL
RECEPTION DIRECTIVITY
(RECEPTION WEIGHT VECTOR)
TRANSMISSION DIRECTIVITY
(TRANSMISSION WEIGHT VECTOR)
PROPAGATION PATH ESTIMATION
PROPAGATION PATH PREDICTION
TRANSMISSION DIRECTIVITY DETERMINATION

FIG. 4A

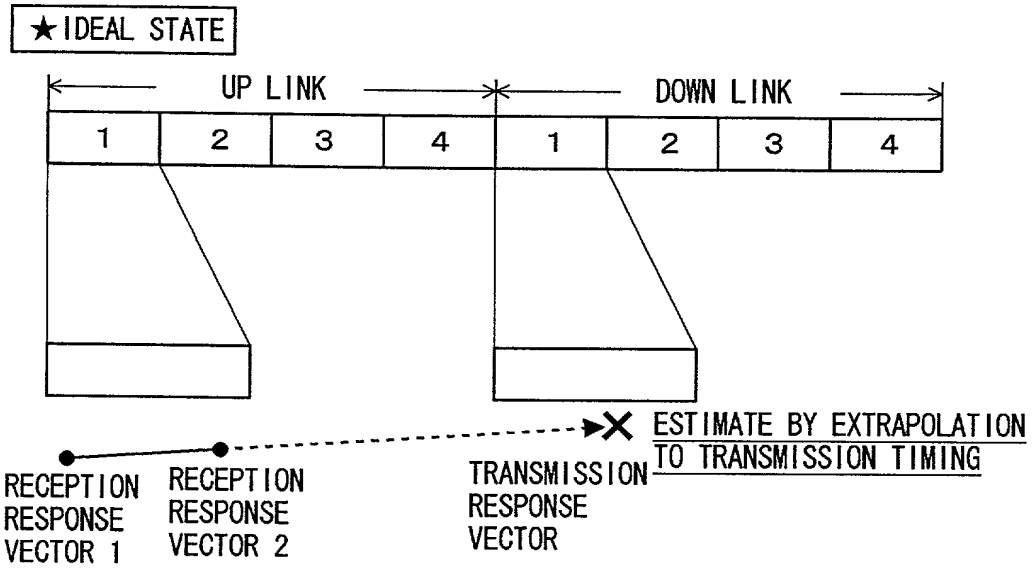

★IDEAL STATE
UP LINK
DOWN LINK
1
2
3
4
1
2
3
4
ESTIMATE BY EXTRAPOLATION TO TRANSMISSION TIMING
RECEPTION RESPONSE VECTOR 1
RECEPTION RESPONSE VECTOR 2
TRANSMISSION RESPONSE VECTOR

FIG. 4B

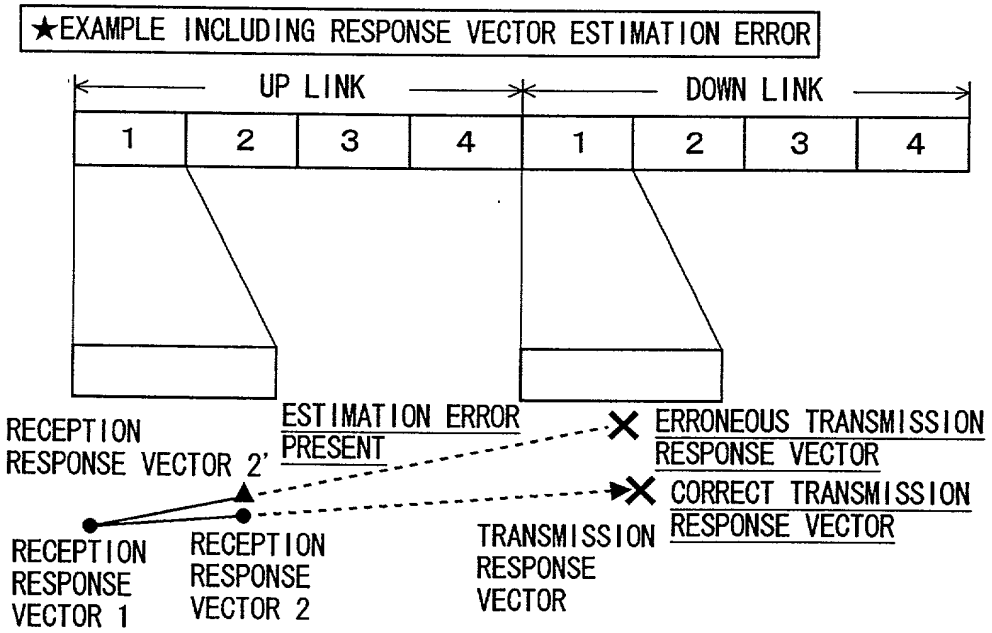
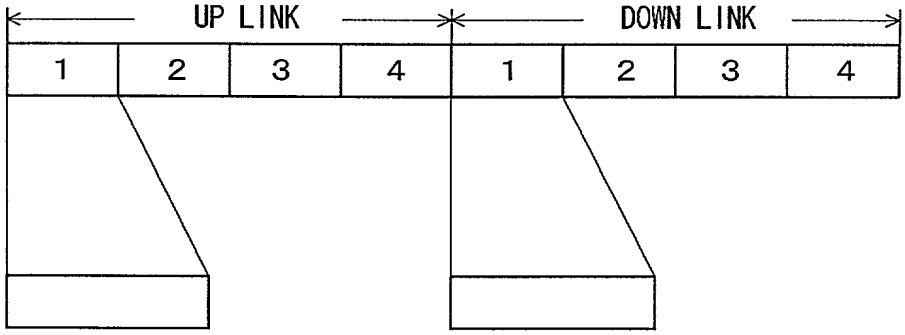
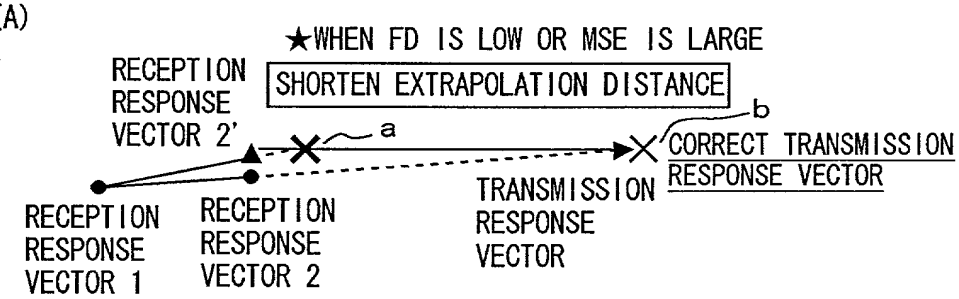

★EXAMPLE INCLUDING RESPONSE VECTOR ESTIMATION ERROR
UP LINK
DOWN LINK
1
2
3
4
1
2
3
4
RECEPTION RESPONSE VECTOR 2'
ESTIMATION ERROR PRESENT
ERRONEOUS TRANSMISSION RESPONSE VECTOR
CORRECT TRANSMISSION RESPONSE VECTOR
RECEPTION RESPONSE VECTOR 1
RECEPTION RESPONSE VECTOR 2
TRANSMISSION RESPONSE VECTOR

FIG. 5


UP LINK
DOWN LINK
1
2
3
4
1
2
3
4

(A)


★WHEN FD IS LOW OR MSE IS LARGE
SHORTEN EXTRAPOLATION DISTANCE
RECEPTION RESPONSE VECTOR 2'
a
b
CORRECT TRANSMISSION RESPONSE VECTOR
TRANSMISSION RESPONSE VECTOR
RECEPTION RESPONSE VECTOR 1
RECEPTION RESPONSE VECTOR 2

(B)

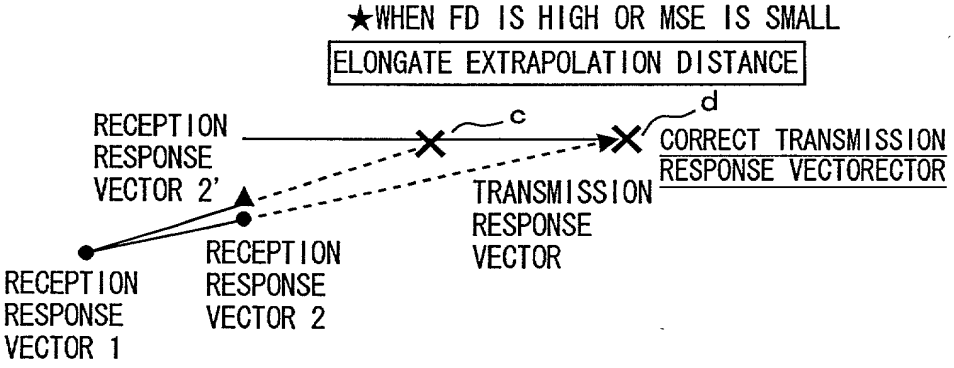

★WHEN FD IS HIGH OR MSE IS SMALL
ELONGATE EXTRAPOLATION DISTANCE
RECEPTION RESPONSE VECTOR 2'
c
d
CORRECT TRANSMISSION RESPONSE VECTORECTOR
TRANSMISSION RESPONSE VECTOR
RECEPTION RESPONSE VECTOR 1
RECEPTION RESPONSE VECTOR 2

FIG. 6

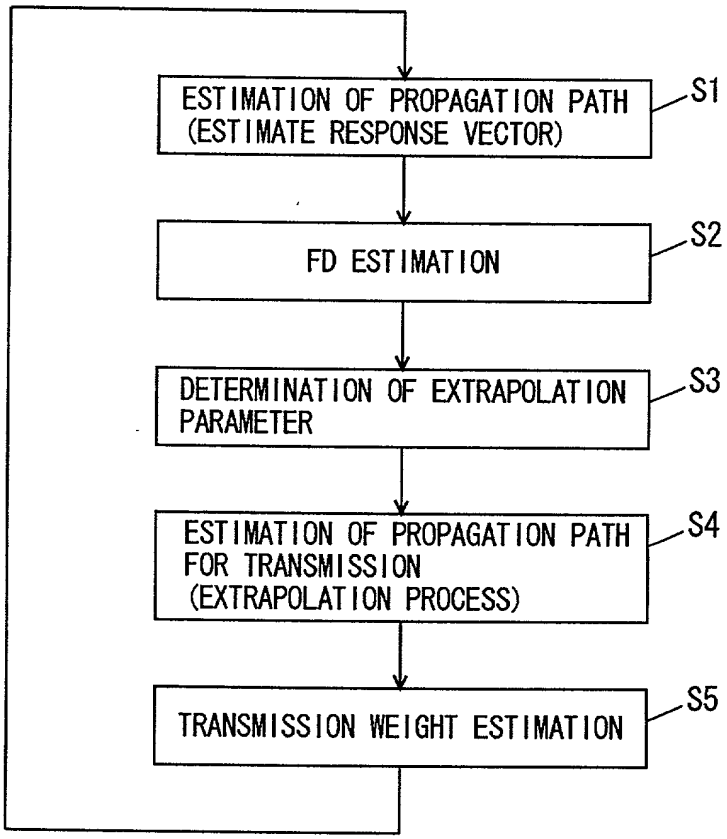

ESTIMATION OF PROPAGATION PATH (ESTIMATE RESPONSE VECTOR)
S1
FD ESTIMATION
S2
DETERMINATION OF EXTRAPOLATION PARAMETER
S3
ESTIMATION OF PROPAGATION PATH FOR TRANSMISSION (EXTRAPOLATION PROCESS)
S4
TRANSMISSION WEIGHT ESTIMATION
S5

FIG. 7

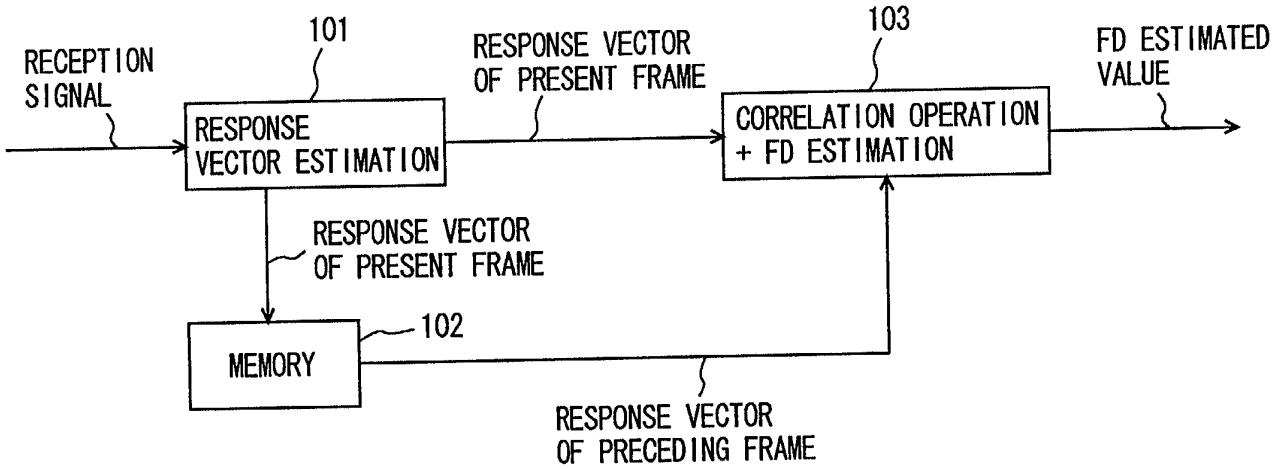

RECEPTION SIGNAL
101
RESPONSE VECTOR ESTIMATION
RESPONSE VECTOR OF PRESENT FRAME
103
CORRELATION OPERATION + FD ESTIMATION
FD ESTIMATED VALUE
RESPONSE VECTOR OF PRESENT FRAME
102
MEMORY
RESPONSE VECTOR OF PRECEDING FRAME

FIG. 8

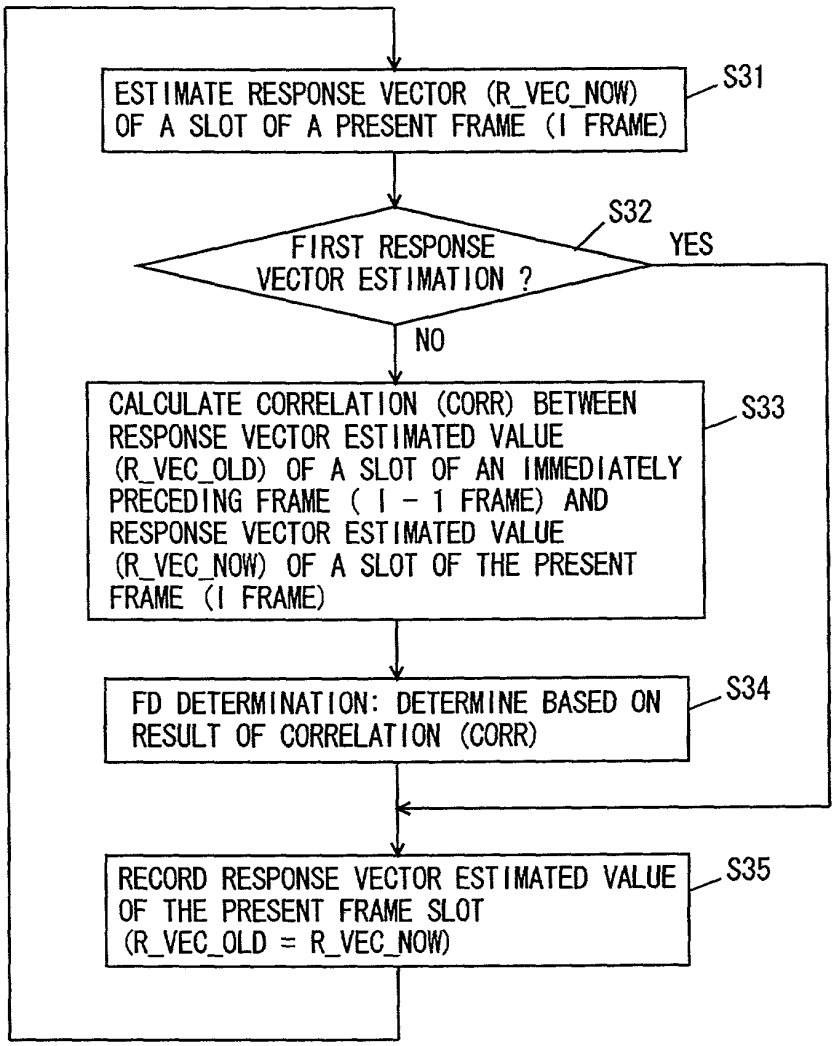

ESTIMATE RESPONSE VECTOR (R_VEC_NOW) OF A SLOT OF A PRESENT FRAME (I FRAME)
S31
FIRST RESPONSE VECTOR ESTIMATION ?
S32
YES
NO
CALCULATE CORRELATION (CORR) BETWEEN RESPONSE VECTOR ESTIMATED VALUE (R_VEC_OLD) OF A SLOT OF AN IMMEDIATELY PRECEDING FRAME (I - 1 FRAME) AND RESPONSE VECTOR ESTIMATED VALUE (R_VEC_NOW) OF A SLOT OF THE PRESENT FRAME (I FRAME)
S33
FD DETERMINATION: DETERMINE BASED ON RESULT OF CORRELATION (CORR)
S34
RECORD RESPONSE VECTOR ESTIMATED VALUE OF THE PRESENT FRAME SLOT (R_VEC_OLD = R_VEC_NOW)
S35

FIG. 9

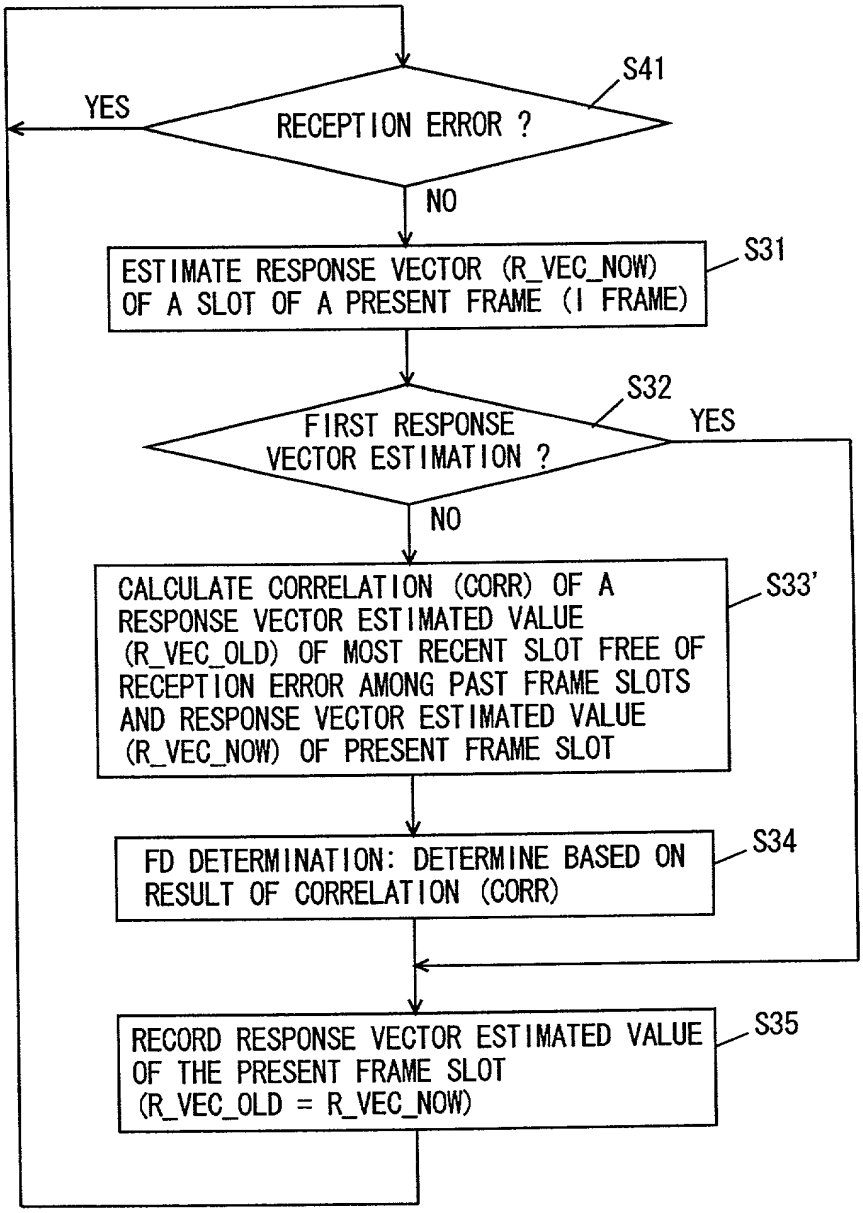

S41
YES
RECEPTION ERROR ?
NO
ESTIMATE RESPONSE VECTOR (R_VEC_NOW) OF A SLOT OF A PRESENT FRAME (I FRAME)
S31
S32
FIRST RESPONSE VECTOR ESTIMATION ?
YES
NO
CALCULATE CORRELATION (CORR) OF A RESPONSE VECTOR ESTIMATED VALUE (R_VEC_OLD) OF MOST RECENT SLOT FREE OF RECEPTION ERROR AMONG PAST FRAME SLOTS AND RESPONSE VECTOR ESTIMATED VALUE (R_VEC_NOW) OF PRESENT FRAME SLOT
S33'
FD DETERMINATION: DETERMINE BASED ON RESULT OF CORRELATION (CORR)
S34
RECORD RESPONSE VECTOR ESTIMATED VALUE OF THE PRESENT FRAME SLOT (R_VEC_OLD = R_VEC_NOW)
S35

FIG. 10

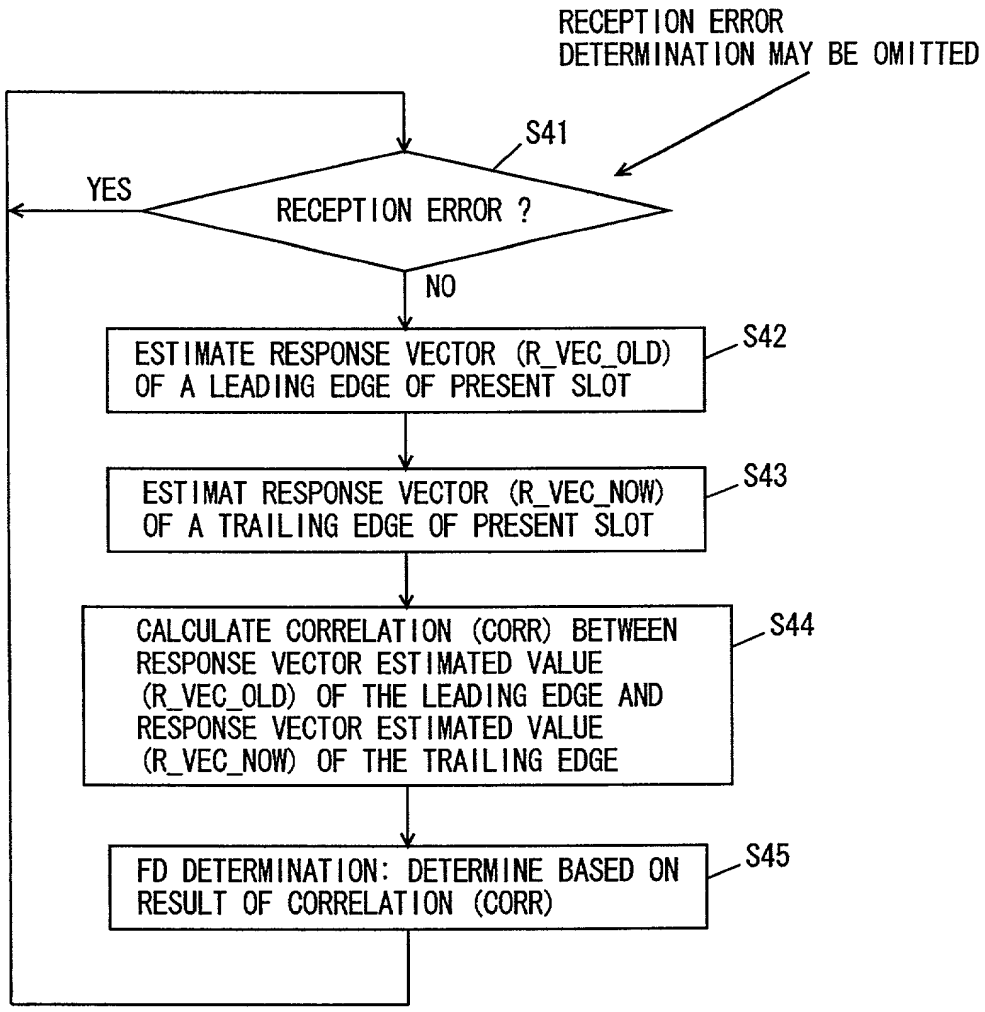

RECEPTION ERROR
DETERMINATION MAY BE OMITTED
S41
YES
RECEPTION ERROR ?
NO
ESTIMATE RESPONSE VECTOR (R_VEC_OLD)
OF A LEADING EDGE OF PRESENT SLOT
S42
ESTIMAT RESPONSE VECTOR (R_VEC_NOW)
OF A TRAILING EDGE OF PRESENT SLOT
S43
CALCULATE CORRELATION (CORR) BETWEEN
RESPONSE VECTOR ESTIMATED VALUE
(R_VEC_OLD) OF THE LEADING EDGE AND
RESPONSE VECTOR ESTIMATED VALUE
(R_VEC_NOW) OF THE TRAILING EDGE
S44
FD DETERMINATION: DETERMINE BASED ON
RESULT OF CORRELATION (CORR)
S45

FIG. 11

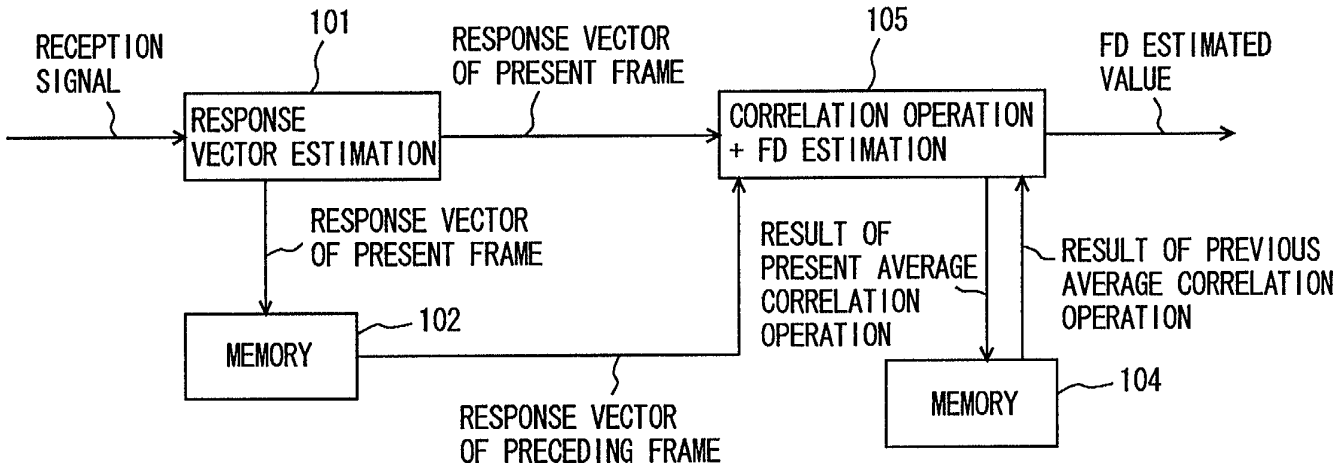

RECEPTION SIGNAL
101
RESPONSE VECTOR ESTIMATION
RESPONSE VECTOR OF PRESENT FRAME
105
CORRELATION OPERATION + FD ESTIMATION
FD ESTIMATED VALUE
RESPONSE VECTOR OF PRESENT FRAME
MEMORY
102
RESPONSE VECTOR OF PRECEDING FRAME
RESULT OF PRESENT AVERAGE CORRELATION OPERATION
RESULT OF PREVIOUS AVERAGE CORRELATION OPERATION
MEMORY
104

FIG. 12

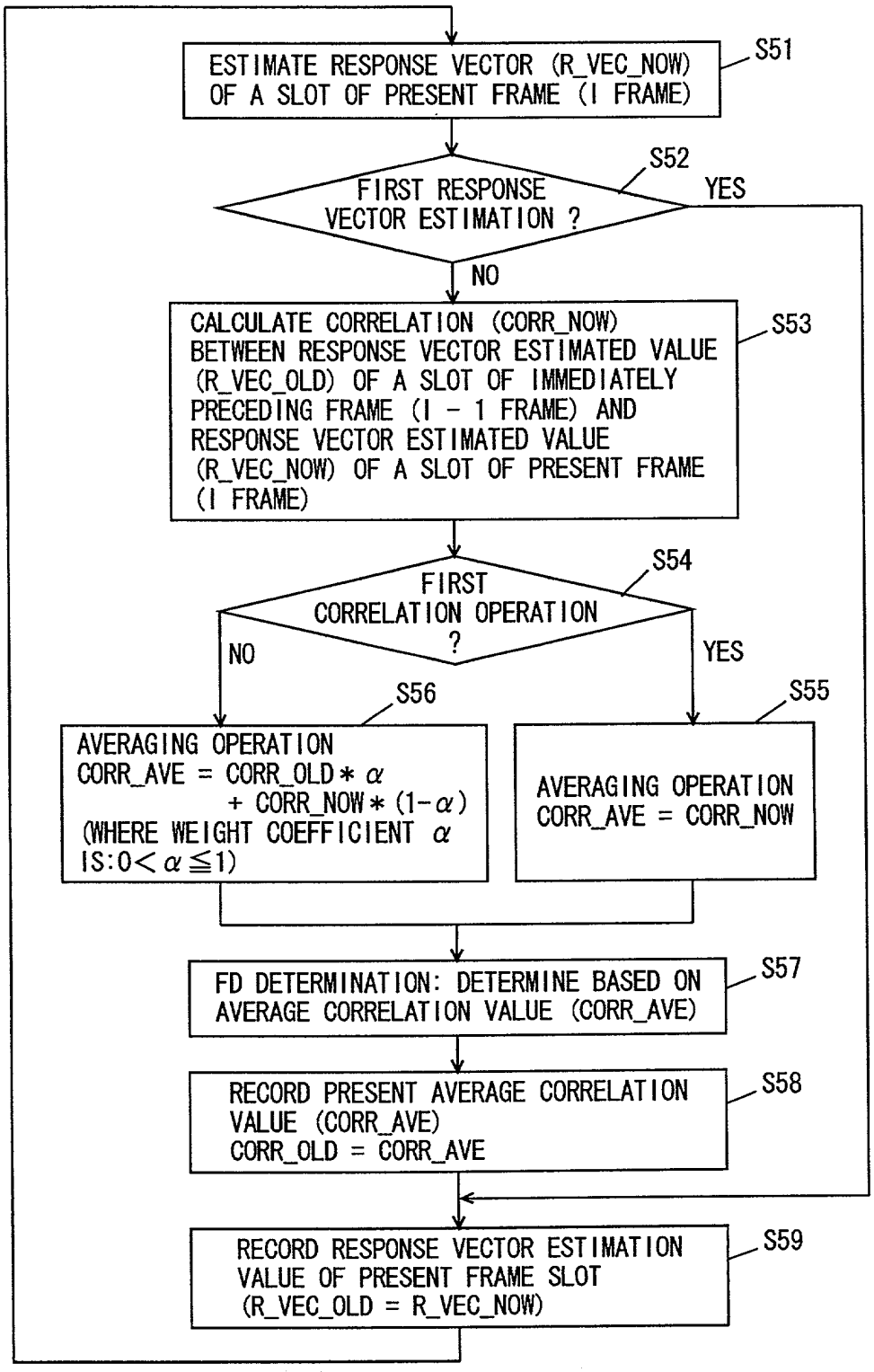

ESTIMATE RESPONSE VECTOR (R_VEC_NOW) OF A SLOT OF PRESENT FRAME (I FRAME)
S51
FIRST RESPONSE VECTOR ESTIMATION ?
S52
YES
NO
CALCULATE CORRELATION (CORR_NOW) BETWEEN RESPONSE VECTOR ESTIMATED VALUE (R_VEC_OLD) OF A SLOT OF IMMEDIATELY PRECEDING FRAME (I - 1 FRAME) AND RESPONSE VECTOR ESTIMATED VALUE (R_VEC_NOW) OF A SLOT OF PRESENT FRAME (I FRAME)
S53
FIRST CORRELATION OPERATION ?
S54
NO
YES
AVERAGING OPERATION
CORR_AVE = CORR_OLD * α
+ CORR_NOW * (1-α)
(WHERE WEIGHT COEFFICIENT α IS:0< α ≦1)
S56
AVERAGING OPERATION
CORR_AVE = CORR_NOW
S55
FD DETERMINATION: DETERMINE BASED ON AVERAGE CORRELATION VALUE (CORR_AVE)
S57
RECORD PRESENT AVERAGE CORRELATION VALUE (CORR_AVE)
CORR_OLD = CORR_AVE
S58
RECORD RESPONSE VECTOR ESTIMATION VALUE OF PRESENT FRAME SLOT (R_VEC_OLD = R_VEC_NOW)
S59

FIG. 13

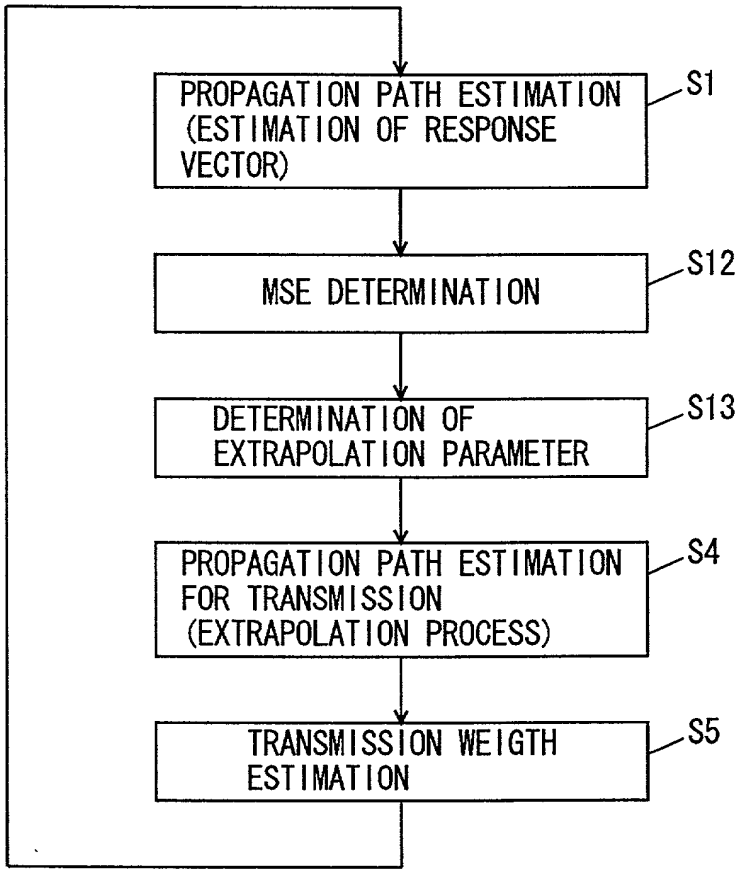

PROPAGATION PATH ESTIMATION (ESTIMATION OF RESPONSE VECTOR)
S1
MSE DETERMINATION
S12
DETERMINATION OF EXTRAPOLATION PARAMETER
S13
PROPAGATION PATH ESTIMATION FOR TRANSMISSION (EXTRAPOLATION PROCESS)
S4
TRANSMISSION WEIGTH ESTIMATION
S5

FIG. 14

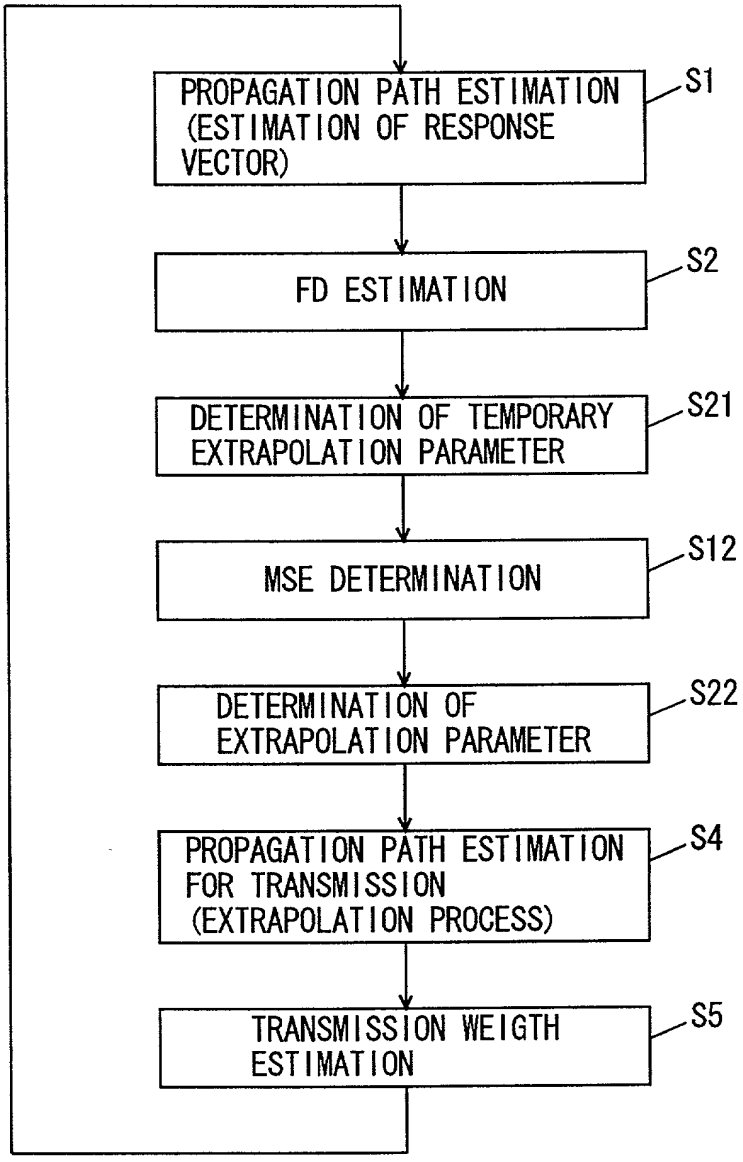

PROPAGATION PATH ESTIMATION (ESTIMATION OF RESPONSE VECTOR)
S1
FD ESTIMATION
S2
DETERMINATION OF TEMPORARY EXTRAPOLATION PARAMETER
S21
MSE DETERMINATION
S12
DETERMINATION OF EXTRAPOLATION PARAMETER
S22
PROPAGATION PATH ESTIMATION FOR TRANSMISSION (EXTRAPOLATION PROCESS)
S4
TRANSMISSION WEIGTH ESTIMATION
S5

FIG.15 PRIOR ART

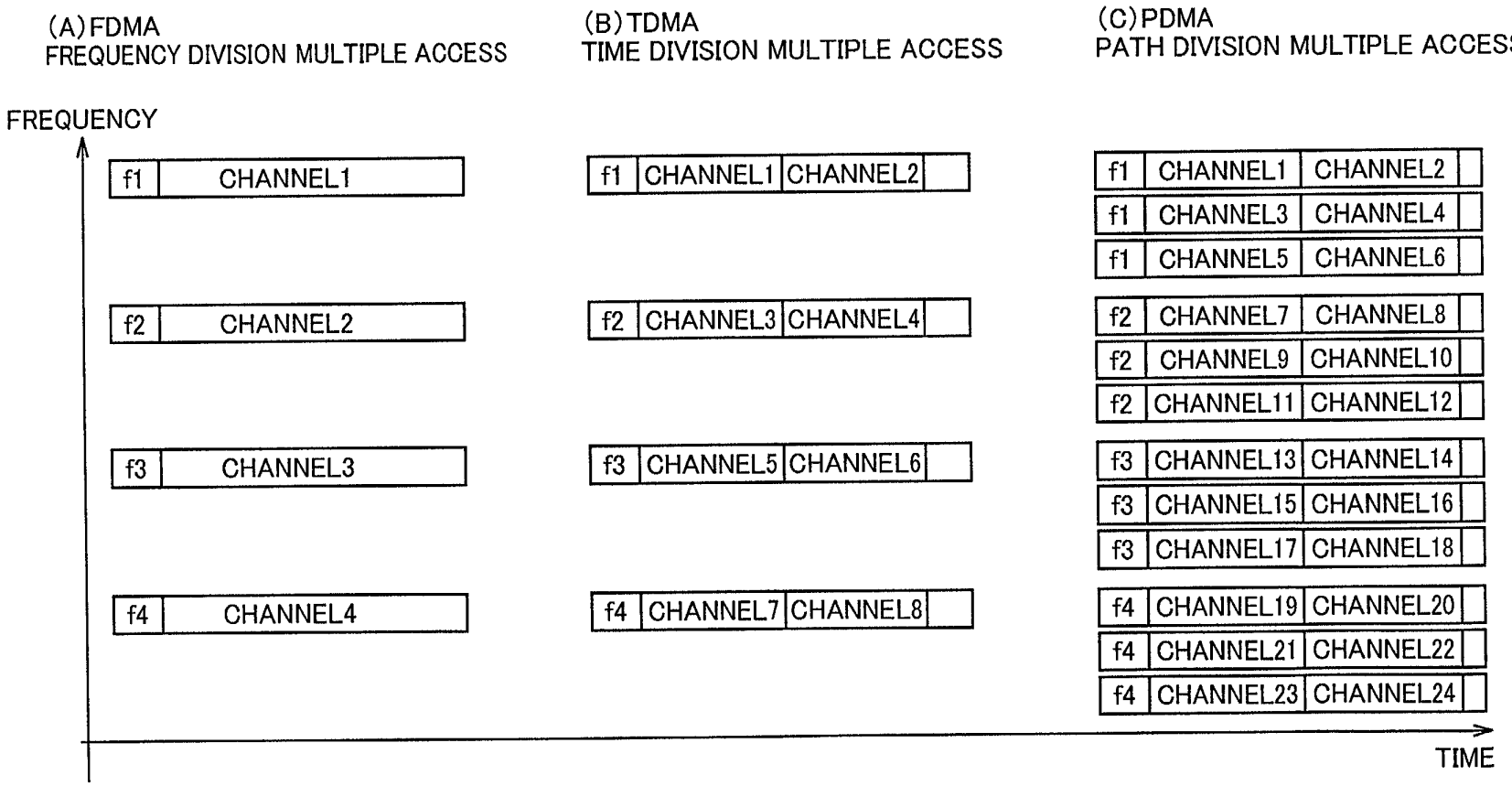


FIG.16 PRIOR ART

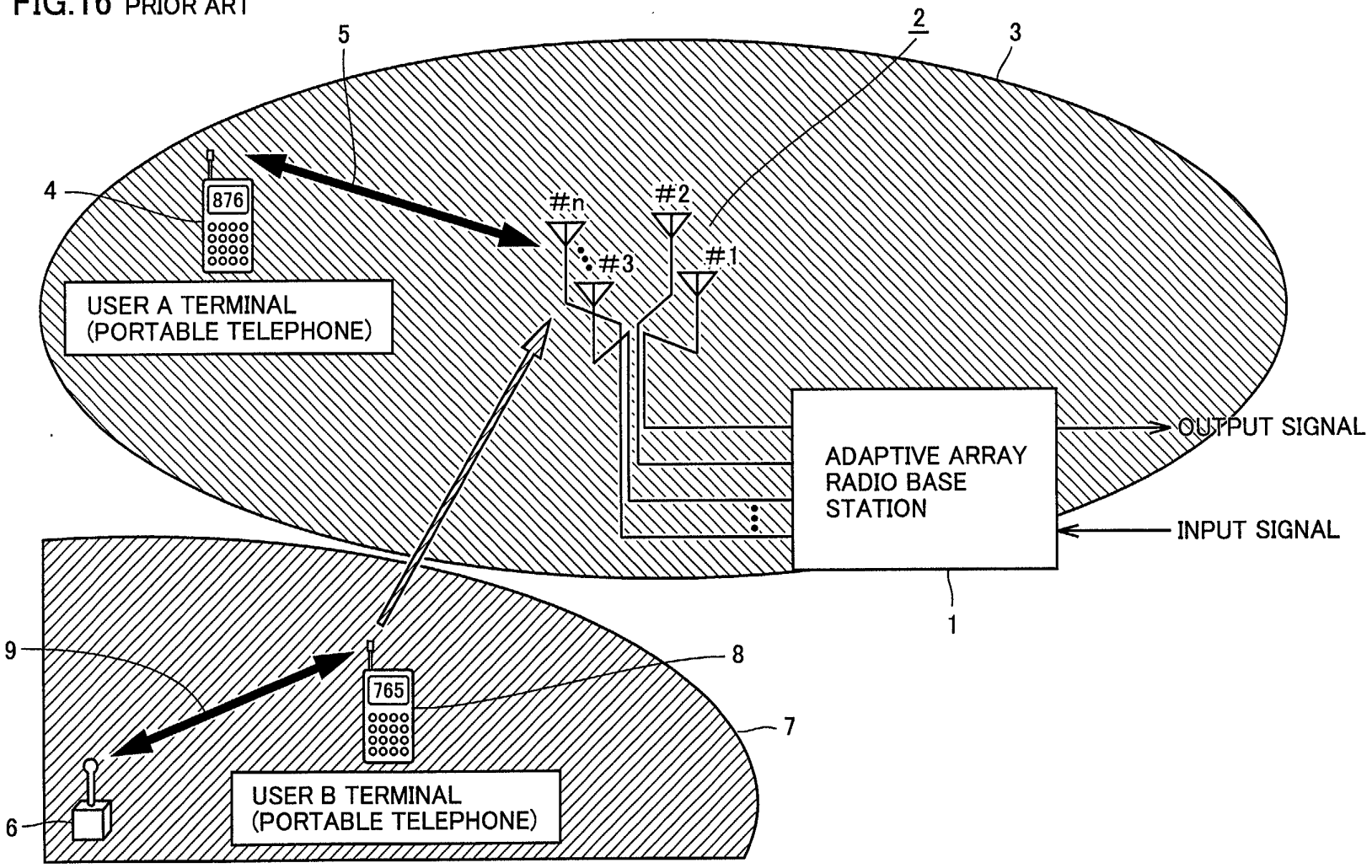


FIG.17 PRIOR ART

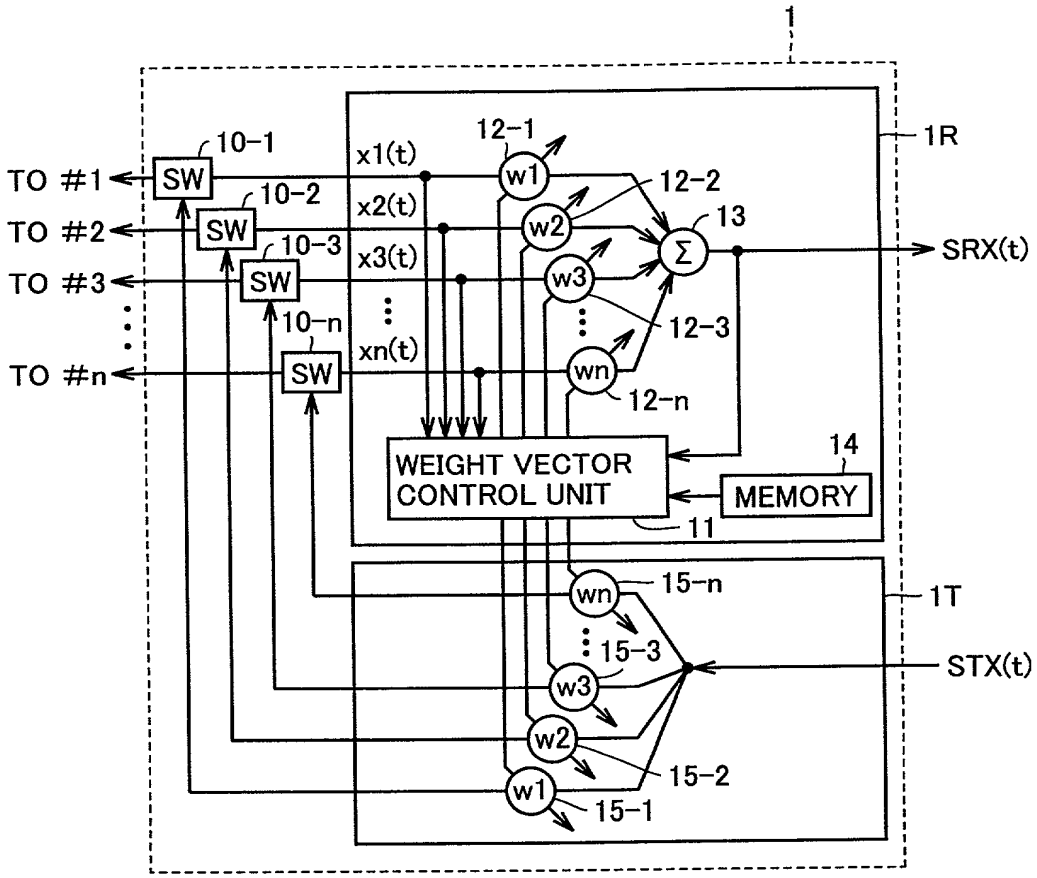


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FIG.18 PRIOR ART

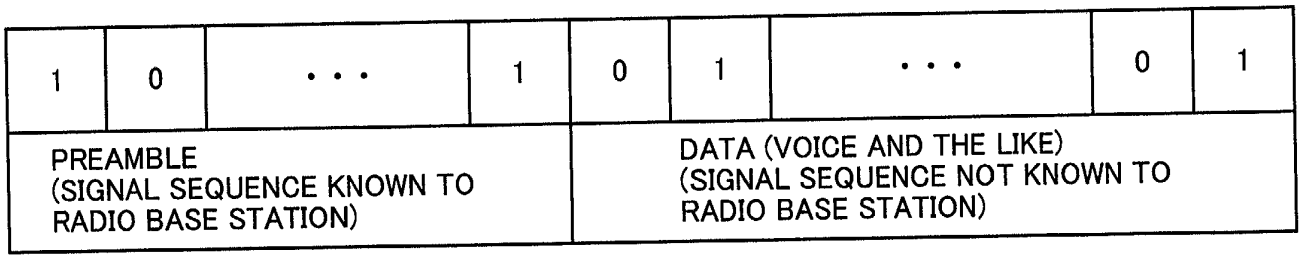
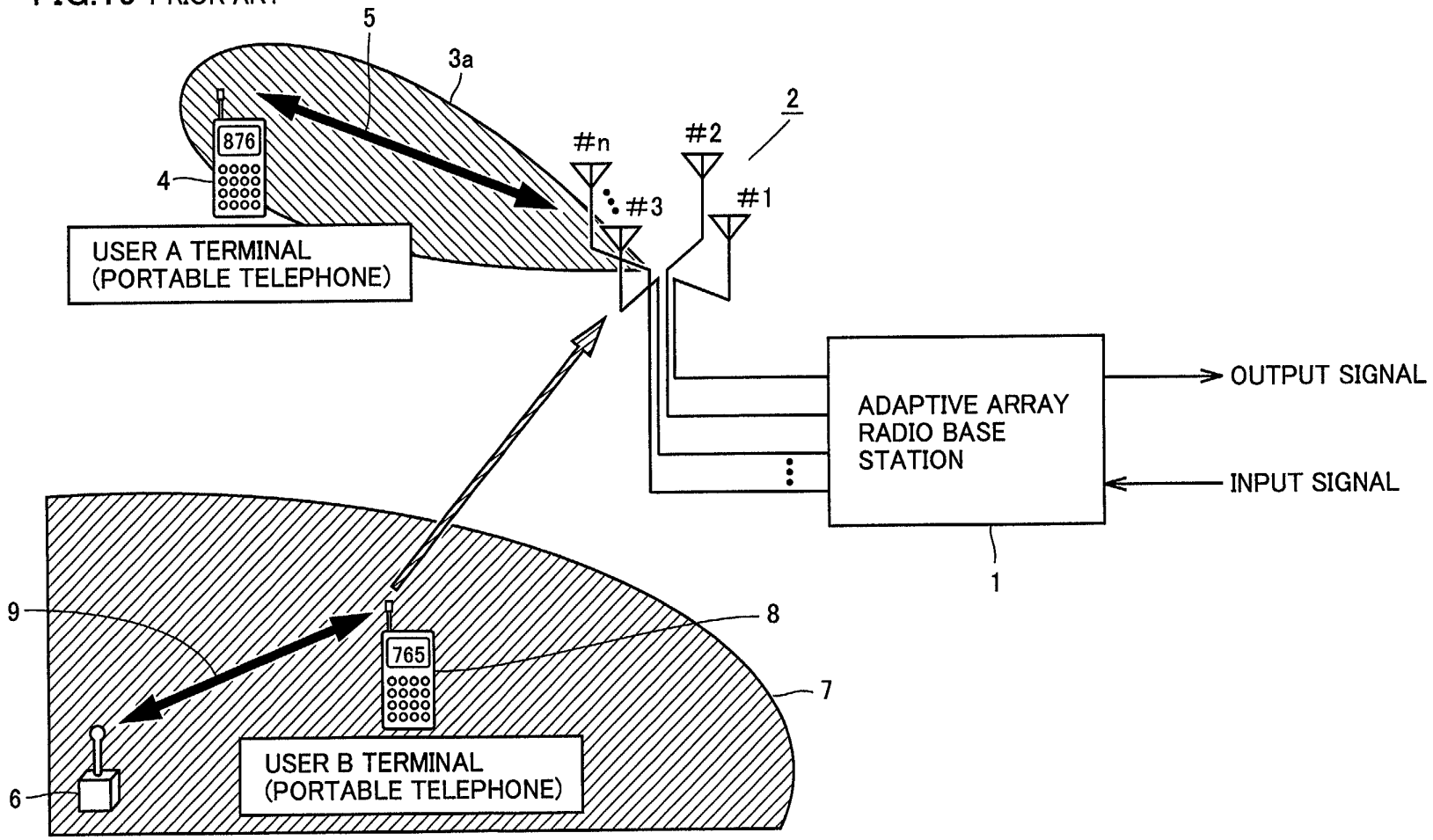
FIG.19 PRIOR ART